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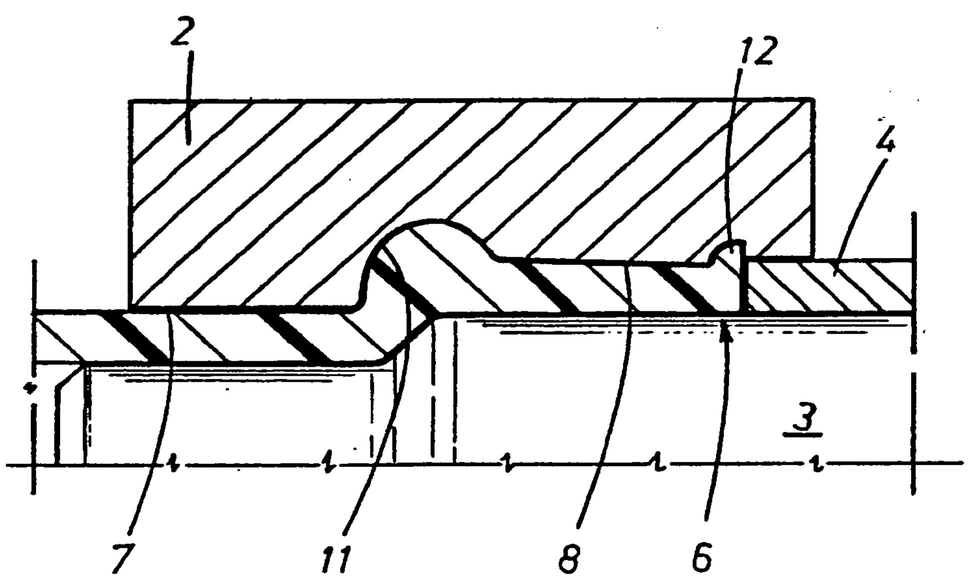
(54) Title: A METHOD OF FORMING STABLE SOCKETS IN POLYETHYLENE PIPES, WITH OR WITHOUT REINFORCEMENT



(57) Abstract

A method of shaping the end of a polyethylene pipe into a socket that will remain stable and secure, with or without added reinforcement, which involves gripping the softened end (6) of the pipe (1) in the bore of a die (2) and enlarging it with a first plug (3), then forcing it into the bore with a second plug (4) that slides over the first in the manner of a sheath, to the end of stabilizing the stretch (5) at which the change in diameter occurs; with the socket formed, the end of the pipe is left to cool at a controlled temperature.

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A method of forming stable sockets in polyethylene pipes, with or without reinforcement

The invention relates to a method of forming sockets in polyethylene pipes that will remain stable, with or without added reinforcement.

There are two types of plastic material currently used in the manufacture of tube, in particular for water supply and waste pipelines, namely, polyvinyl chloride, commonly known as PVC, and polyethylene, abbreviated PE.

Both the materials in question are characterized by advantages and disadvantages alike.

One of the drawbacks of PVC is that it incorporates lead compounds, and is therefore toxic; accordingly, the adoption of PVC pipes for water supply systems is possible only where the plastic can be especially manufactured to a lead-free formula, though such a specification signifies higher production costs.

A further drawback of PVC tube is that its rigidity and fragility will often dictate the necessity for pipes to be ensheathed or otherwise strengthened with concrete or cement mortar. This requirement is in evidence most of all where large diameter pipes, such as those used for main fluid supply lines, are buried underground; the pipes will generally be laid in ditches excavated along roads or pathways, which are subsequently filled in with earth so that the

broken surface can be restored to its pre-excavated condition. If no reinforcement were provided, or if the fill were to subside at a later juncture, a PVC pipe would certainly fracture, unable to accommodate the resultant movement or stress.

Another drawback of PVC is that it crystallizes and ages with the passage of time, becoming even more fragile.

By contrast, one of the advantages of PVC is its post-forming stability. Sockets are formed in each length of pipe by a machine located alongside the continuous extruding equipment. The continuous tube is cut into discrete lengths, and these are fed into a machine which takes them through a further station incorporating an oven; one end of the single pipe is heated, inside and out, to a temperature approaching that at which the material softens, whereupon the pipe is transferred immediately to a forming station and the outside of the heated end gripped in a die; finally, an exanding plug is inserted and spread to enlarge the diameter and create the socket.

Polyethylene tube is used for special applications, as it neither ages nor pollutes, and possesses good elasticity.

The only drawback with pipes fashioned in PE is that of their tendency to contract after heating; forming a socket is therefore problematical, as the internal diameter tends to shrink, if not back to its initial size, then at least to an extent that it becomes impossible to insert the spigot of another pipe.

Currently, this drawback is overcome by butt-joining the pipes end to end and either fitting a separate sleeve, or welding them together.

The first such method involves the use of a sleeve provided internally with an electrical resistance, which melts the material brought into contact with it; thus, both the sleeve and the spigots of the two pipes inserted into it are fused, and adhesive and sealing compounds can be dispensed with.

This method is somewhat impractical when the pipes are of large diameter, as the external diameter of the sleeve needs to be greater still. As a result, laying a pipeline becomes a difficult and involved operation, and the initial cost of manufacturing the material necessary to form each single joint is substantially double that required for an ordinary spigot-and-socket, since there are effectively two socket lengths used at each connection.

An additional drawback encountered with this method is that a considerable outlay of capital becomes necessary in order to hold a stock of sleeves for different sizes of pipe.

The second method mentioned consists in locating a plate, or disc, between the ends of two pipes, and heating it to a temperature in the region of that which will soften the polyethylene material; the two ends are then offered to the two opposite surfaces of the disc. The moment the plastic has heated to the appropriate temperature, the disc is removed, whereupon the pipes are butted firmly together and

held until a faultessly welded join is obtained. Here too, the method remains feasible as long as the pipe remains of relatively small diameter, whereas with larger sizes, say, of the order of one metre, such as are utilized in urban waterworks, the need arises to provide equipment on site such as will be capable of supporting a disc to match the diameter of the pipes; with the larger diameters, therefore, one has problems with transportation and use of the necessary equipment.

A further aspect to be taken into account is that the elastic properties typical of PE can constitute a hazard when the pipeline is used to convey fluids, whether liquid or gas, at high hydraulic pressures. In this instance, one is faced not only with the problem of the socket's stability, but also, with the risk that seals which may be located between the breasted surfaces of the joined pipes may be forced out of their seats, the result of which will be a violent escape of the piped fluid.

There are drawbacks, at all events, even in cases where the end of a pipe in PE is provided with a socket of nominally stable embodiment, inasmuch as there is always the possibility that the pipe will rupture at the point where the change in diameter occurs, this being the area most subject to stress.

The object of the invention is to provide a method of forming sockets in pipes fashioned from plastic, including polyethylene, in particular, of forming a socket that will remain stable in the long term, and

which can be assembled with or without reinforcement and rendered fluid-tight either with sealing rings, or by fusion with the mating surface of the spigot; similarly, it is sought to ensure that such a socket will withstand the mechanical stresses deriving from its embodiment and assembly.

The stated object is amply realized by adoption of the method as characterized in the appended claims, which consists substantially in forcing the softened and enlarged socket end of a pipe into the bore of a die so as to stabilize the area at which the change in diameter occurs, and then cooling the formed socket in controlled temperature conditions.

One of the advantages provided by the invention is that of its simplicity; the method disclosed can be implemented on the premises where the PE pipes are manufactured, so that the practical difficulties connected with forming sockets are eliminated, even in the case of large diameters.

The invention will now be described in detail, by way of example, with the aid of the accompanying drawings, in which:

figs 1 to 3 are axial sections illustrating three steps of the method according to the invention, as used in the formation of a socket without any added reinforcement;

fig 4 illustrates an alternative implementation of the method as in figs 1 to 3, which is used to form a reinforced socket for assembly with an additional seal.

In the method according to the invention disclosed, the end 6 of a polyethylene pipe 1 to be shaped into a socket is heated (generally in an oven, regulated to generate a temperature approaching that which will soften the PE), then embraced by a die 2.
The die 2 affords an axial bore 10 divided into at least two distinct sections of dissimilar diameter, denoted 7 and 8, and an interconnecting section 11 of essentially tapered embodiment; in the example of fig 1, a recess 9 is also incorporated, at the point where the wider diameter section 8 merges with the interconnecting section 11, the diameter of which is greater than that of the wider section 8.
The pipe 1 is clamped in the die 2 about its smaller diameter section 7, in such a way that the end 6 for shaping is freely encompassed by the wider diameter section (see fig 1).
Next, the softened end 6 is penetrated by a first plug 3 that deforms the PE material, expanding it to the point that its outer surface makes contact with the wider diameter section 8 of the die (fig 2).
It is an essential feature of the method disclosed that the die 2 is now penetrated by a second plug 4, which ensheaths the first plug 3 and registers with the surface of the wider diameter section 8. More exactly, the second plug 4 fills the space between the first plug 3 and the wider diameter section 8 (see fig 2), and thus functions as an annular ram.
The entry of the second plug 4 subjects the softened end 6 of the pipe 1 to a compressive force, with the

result that the plastic material fills the available space afforded by the bore 10 to capacity, including that of the recess 9 (if incorporated).

The shaped end 6 is then cooled at a controlled temperature, held in the die 2 for a length of time sufficient to allow rehardening; the actual duration will depend on the thickness of the pipe wall.

Another important aspect of the method is that the temperature of the shaped end 6 must be regulated in such a way as to permit a successful reconstitution of the plastic material, or at all events, such as enables it to absorb any internal tension components produced by the forcing stroke.

In effect, with cooling brought about at controlled temperature, any internal tension stemming from the applied compressive force can be fully accommodated by the material, and the change in shape is rendered more stable; the forcing step also has a stabilizing effect, as it helps to ensure faultless forming at the very point 5 where a change in diameter occurs.

The temperature of the die 2 is suitably regulated, i.e. raised when empty prior to gripping the pipe 1, and lowered when in operation, with control effected independently of the heat generated by introduction of the first plug 3 and by the forcing stroke of the second plug 4.

In practice, the end 6 of the pipe will be heated to 140...150 °C or thereabouts, whereas the die 2 is held at a temperature in the region of 70...80 °C.

The recess 9 can either be restricted to the point

where the wider diameter section 8 merges with the interconnecting section 11 and/or extended to occupy the entire interconnecting section 11, in order to obtain greater thickness; this will help to prevent shrinkage of the socket end 6 when cooled, and at the same time, to avoid rupture at the more highly stressed area where the change in diameter occurs. The option also exists of using a circumferentially continuous or non-continuous recess 9; in the latter instance, the corresponding section of the finished socket will appear as a succession of longitudinal ribs, rather than a simple bulge.

The finished socket 6 of fig 3 also exhibits a lip, denoted 12, which is formed by the forcing stroke of the second plug 4 and assists further in preventing shrinkage of the socket end 6.

With the socket embodied as illustrated, it becomes possible to locate a ring of electrical resistances between the breasted surfaces of the socket and the corresponding spigot, which will fuse the material of the two surfaces together as described at the outset.

Fig 4 illustrates an alternative version of the method, in which the socket formed in the pipe 1 is strengthened by a metal collar 20 encircling the part of larger diameter 21. With this arrangement, a groove 22 can be formed either in the spigot 6 of the pipe occupying the socket, or in the socket itself, to accommodate a high pressure seal 23; the seal illustrated is a lip type of 'V' cross section,

seated with the vertex of the V directed toward the mouth of the socket, and with the outer lip engaging the inside wall of the socket.

Here too, the socket is formed by implementation of the method described above, having first positioned the collar in a corresponding seat afforded by the die 2. Pressure in the pipeline can be raised to a given continuous value without risk, as the seal 23 prevents any escape of the conveyed fluid; the metal collar 20 ensures that the socket will not be forced out of shape, and accordingly, there is no danger of the seal 23 being ejected from its groove 22.

Claims

1) A method of forming stable sockets in polyethylene pipes, with or without reinforcement, characterized in that it comprises the steps of:

- heating the end (6) of a pipe (1) to a temperature approaching that which will soften the material from which the pipe is fashioned;
- gripping the heated end (6) of the pipe (1) in a die (2) affording an axial bore (10) that exhibits two sections (7, 8) of dissimilar diameter separated by at least one section (11) of varying diameter;
- penetrating the pipe (1) coaxially with a first plug (3), which enlarges the heated end (6) to the point of making contact with the wider diameter section (8) of the axial bore (10) of the die (2);
- penetrating the die (2) with a second plug (4) that ensheaths the first plug (3) and registers with the wider diameter section (8) of the bore (10), the effect of which is to apply a compressive force to the heated end (6) of the pipe (1) such as will stabilize that part of the socket where a change in diameter occurs;
- cooling the heated end (6) of the pipe (1) at a controlled temperature following formation of the socket.

2) A method as in claim 1, wherein the section (11) of varying diameter is such as will permit of obtaining a thickness greater than that of the remainder of the pipe (1) and of the socket.

3) A method of forming stable sockets in polyethylene pipes, with or without reinforcement,
characterized
in that it comprises the steps of:
- heating the end (6) of a pipe (1) to a temperature approaching that which will soften the material from which the pipe is fashioned;
- gripping the heated end (6) of the pipe (1) in a heated die (2) affording an axial bore (10) that exhibits two sections (7, 8) of dissimilar diameter separated by a section (11) incorporating a recess (9) of diameter greater than that of the adjacent section of wider diameter (8);
- penetrating the pipe (1) coaxially with a first plug (3), which enlarges the heated end (6) to the point of making contact with the wider diameter section (8) of the axial bore (10) of the die (2);
- penetrating the die (2) with a second plug (4) that ensheaths the first plug (3) and registers with the wider diameter section (8) of the bore (10), the effect of which is to apply a compressive force to the heated end (6) of the pipe (1) such as will invest it with a thickness greater than that of the remainder of the pipe, at least at the part (5) of the socket where a change in diameter occurs;

- cooling the heated end (6) of the pipe (1) at a controlled temperature following formation of the socket.

4) A method as in claim 1 or claim 3, wherein the die (2) is held at a substantially constant temperature in the region of 70 to 80 °C both during penetrating of the plugs (3, 4) and during the cooling step.

5) A method as in claim 1 or claim 3, wherein the end (6) of the pipe (1) to be formed into a socket is preheated to a temperature in the region of 140 to 150 °C.

6) A method as in claim 3, wherein the recess (9) is incorporated into the die (2) exclusively at the point where the wider diameter section (8) of the axial bore (10) begins tapering down, in such a way that the thickness of the formed socket is increased only at the point (5) where a change in diameter occurs.

7) A method as in claim 3, wherein the recess (9) is incorporated into the die in non-continuous fashion, such that the formed socket exhibits a succession of ribs located at the point (5) where a change in diameter occurs, or at least, at the point where the variation in diameter is at its widest.

FIG1

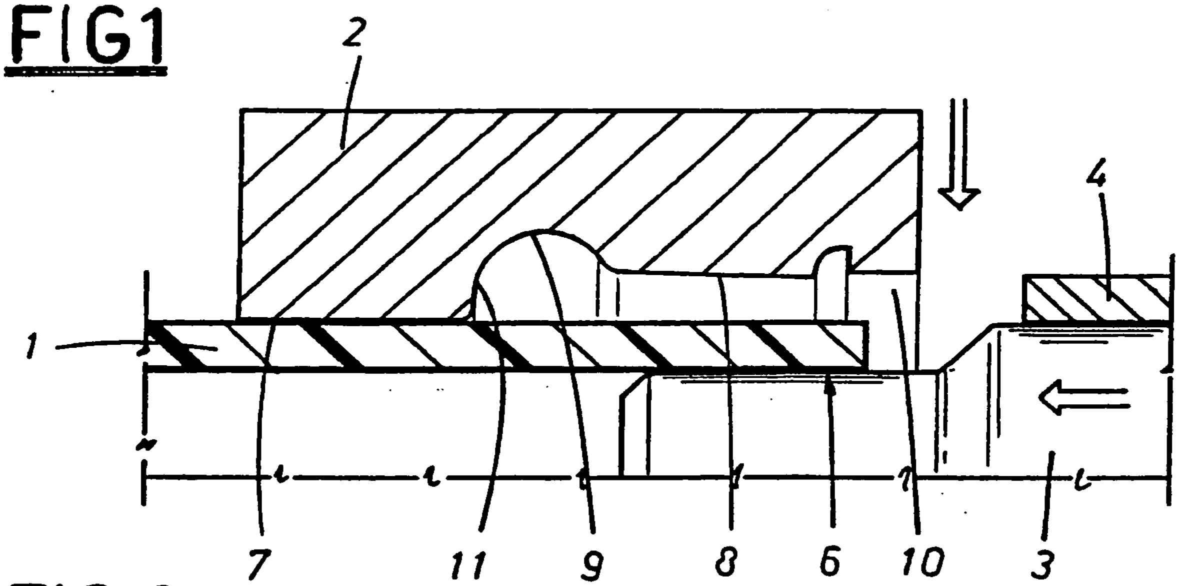


FIG 2

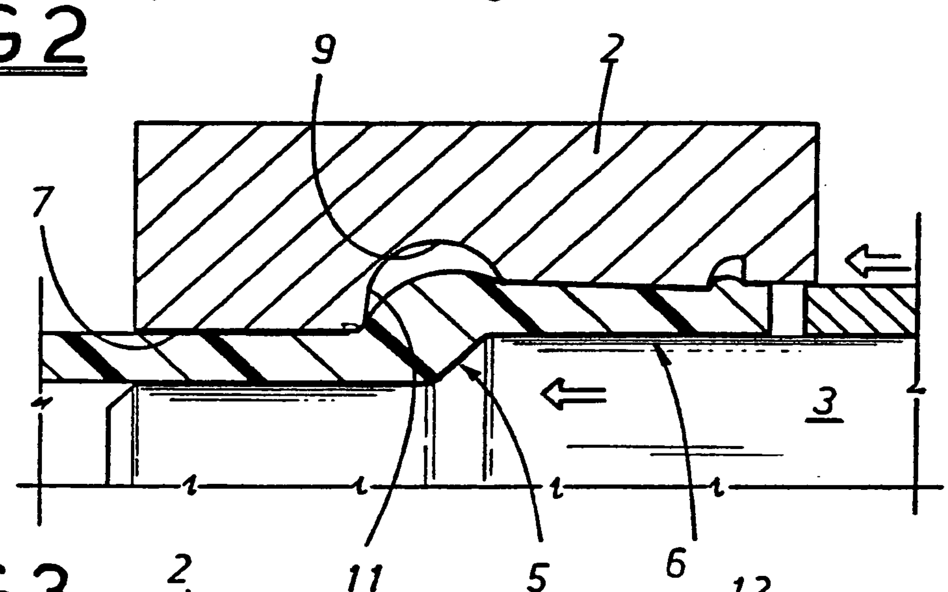
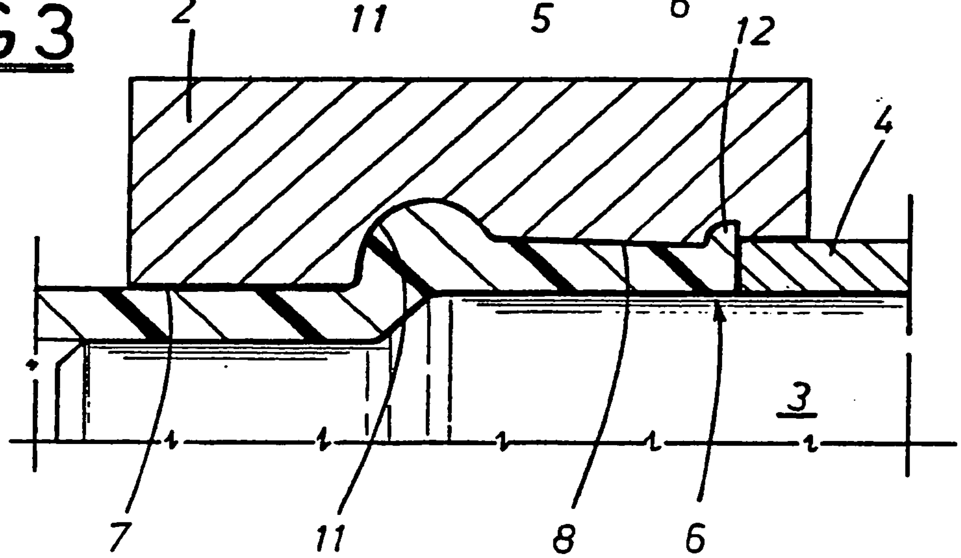


FIG 3



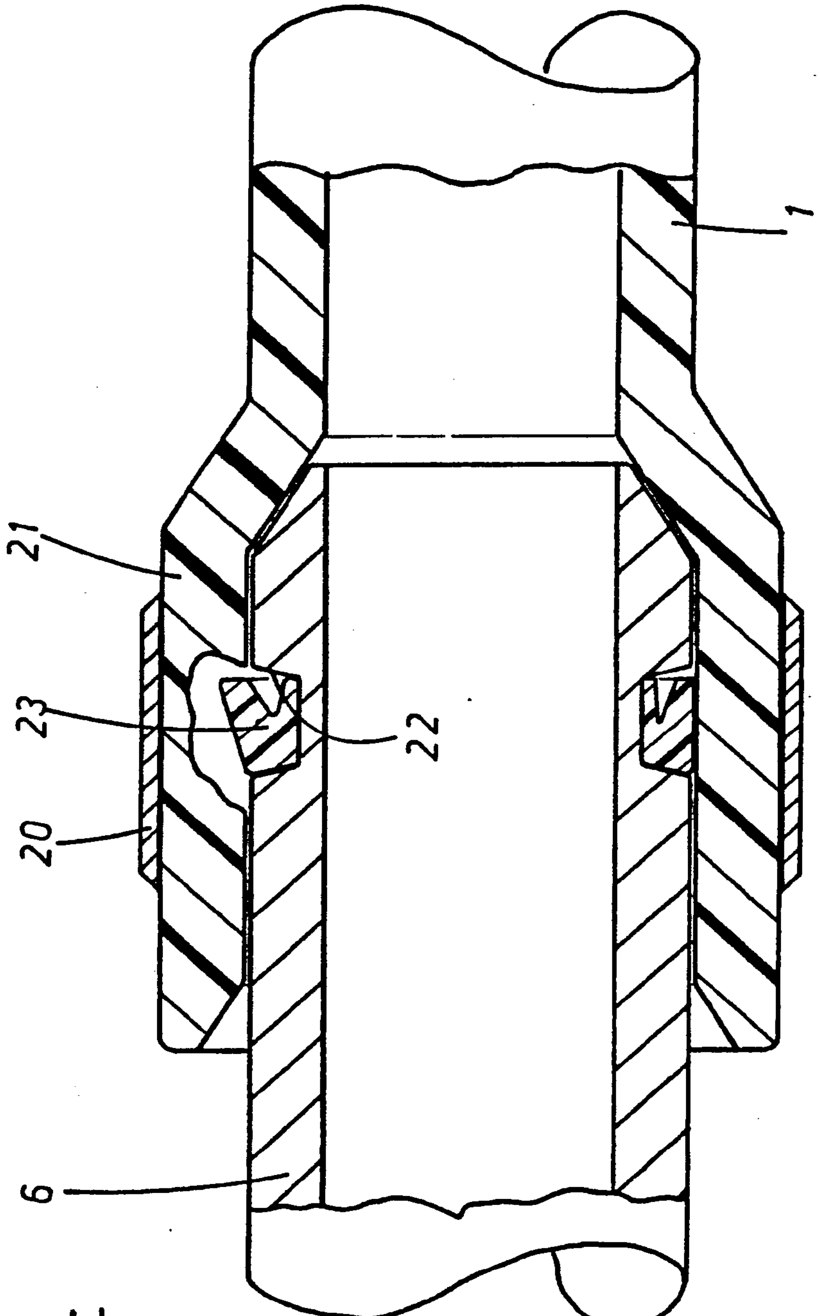


FIG 4

INTERNATIONAL SEARCH REPORT

International Application No PCT/IT 88/00051

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4] B 29 C 57/04

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 29 C; F 16 L;

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	Patent Abstracts of Japan, abstract of JP 52-50970, publ 28 November 1978, (KUBOTA TEKKO K.K.) *Abstract* ---	1-7
X	Patent Abstracts of Japan, abstract of JP 52-108048 publ 31 March 1979, (KUBOTA TEKKO K.K.) *Abstract* ---	1-7
X	Patent Abstracts of Japan, abstract of JP 53-78162, publ 27 January 1980, (KUBOTA TEKKO K.K.) *Abstract* ---	1-7
X	US, A, 3360826 (P. E. LORANG) 2 January 1968, see especially first paragraph ---	1-7
X	US, A, 3749543 (STANSBURY) 31 July 1973, whole document ---	1-7

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
27th September 1988	11 NOV 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
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ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. PCT/IT 88/00051
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 01/09/88
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JP 52050970	23-04-77	None	
JP 52108048	10-09-77	None	
JP 53078162	11-07-78	None	

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